

Asynaptic Meiosis in three species of Lepidopteran males

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Abstract.—Studies on the spermatocytic chromosomes from late pupal preparations of three lepidopteran species, *Arctia ricini* Fabr., *Polytela gloriosae* Fabr. and *Precis lemonias* Linn. have revealed a very low frequency of anomalous diakinesis and metaphase I cells. Many unpaired bivalents were observed having parallel oriented homologues, well separated from each other, in addition to some normal bivalents. Such early resolution of many bivalents to univalent homologues might have been either due to lack of chiasmata or due to presence of weak chiasmata undergoing rapid terminalisation. Since this feature appeared as early as late diplotene and diakinesis, the lack of chiasma formation still earlier in pachytene might have given rise to asynaptic meiotic patterns leading to anaphasic irregularities resulting in abortive segregation of homologues. Since asynaptic meiosis is observed in late pupae, hormonal factors as well as genetic factors might be responsible for initiating the process.

The occurrence of achiasmatic meiosis has been reported in many animal species (Bauer 1953; White 1954; Ullerich 1961; Suomalainen 1965; Suomalainen et al. 1973). It is best known in certain groups of insects where the heterogametic sex usually shows asynaptic meiosis during gametogenesis (Beermann 1954; White 1954, 1973). The Lepidoptera, which exhibit female heterogamety, have not been considered to have chiasmata formed in females during oogenesis. Distinct chiasmata do occur during spermatogenesis in males (Maeda 1939; Federley 1943, 1945; Suomalainen 1965, 1969; Suomalainen et al. 1973; Traut 1977). Exceptional asynaptic chromosomes have been reported from abnormal spermatocytes in meiotic male lines by Srivastava and Gupta (1962) in *Philosamia ricini* and by Virkki (1963) in *Diatrea saccharalis*. In this connection studies made on the spermatocytic chromosomes of three lepidopteran species, *Arctia ricini* Fabr. (Arctidae), *Polytela gloriosae* Fabr. (Noctuidae) and *Precis lemonias* Linn. (Nymphalidae) have revealed similar anomalous features during the first meiotic prophase which are reported below.

The larvae of *Arctia ricini*, *Polytela gloriosae* and *Precis lemonias* were collected from their respective host plants and were reared in the laboratory. Testes of mature larvae and pupae were dissected and were

fixed in 1:3 acetic acid-ethanol. Permanent squash preparations of the materials were made and the slides were stained, in Heidenhein's iron haematoxylin. The chromosomes were drawn using a camera lucida with a total magnification of about $\times 2000$.

Gonial metaphases in *A. richini*, *P. gloriosae* and *P. lemonias* revealed 62 minute, almost equal sized dot shaped chromosomes showing the diploid chromosome number, $2n=62$ in all the three species (Fig. 1, 4 & 7). Normally in all diakinesis and metaphase I plates 31 bivalents were encountered and the diakinesis bivalents showed chiasma bearing shapes like 'V' rod, dumb-bell- and cross-shaped structures. The first metaphase bivalents were maximum condensed and appeared oval (Fig. 2, 5 & 8). However, a very low percentage of abnormal primary spermatocytes of pupal testes revealed a large number of univalent chromosomes in addition to some bivalents during diakinesis and metaphase I of all the three species (Fig. 3, 6 & 9). In the diakinesis cell of *A. richini* (Fig. 3) 18 bivalents and 26 nonpaired univalents; in metaphase I of *P. gloriosae* (Fig. 6) 12 bivalents and 38 univalents and in *P. lemonias* (Fig. 9) 22 bivalents and 18 univalents were observed. The disposition of the univalent chromosomes in closely associated pairs, without any contact, indicated these may be the unpaired homologues of bivalents which have either failed to form chiasmata or which had undergone early terminalisation, while in normal cells (Fig. 2, 5 & 8) pairing continued until first metaphase of all bivalents. Since, these features appeared as early as diakinesis involving majority of bivalents and terminalisation in normal cells is not complete until first metaphase they might have arisen through nonpairing of homologues even early in diplotene and not through early resolution. Although the number of cells involved were less, yet it was not insignificant. Since, their frequency increased from early pupa to eclosion with an increase in the involvement of bivalents until all bivalents showed unpaired homologues. Each of the secondary spermatocytes showed 31 univalent chromosomes at metaphase II without exception indicating a normal segregation of homologues in the second anaphase.

Normally meiosis is achiasmatic in the females and chiasmatic in the males of Lepidoptera (Maeda 1939; Federley 1945; Suomalainen 1965; Suomalainen, Cook and Turner 1977), although genetic data showing crossing over between a pair of linked genes in *Ephesia kuhniella* females suggest indirect evidence of chiasma formation (Kuhn and Berg 1855). Further Virrki (1963) has observed both chiasmatic and achiasmatic meiotic cells in variable proportion in the male pupae of *Diatrea saccharalis*. The findings of the present work is

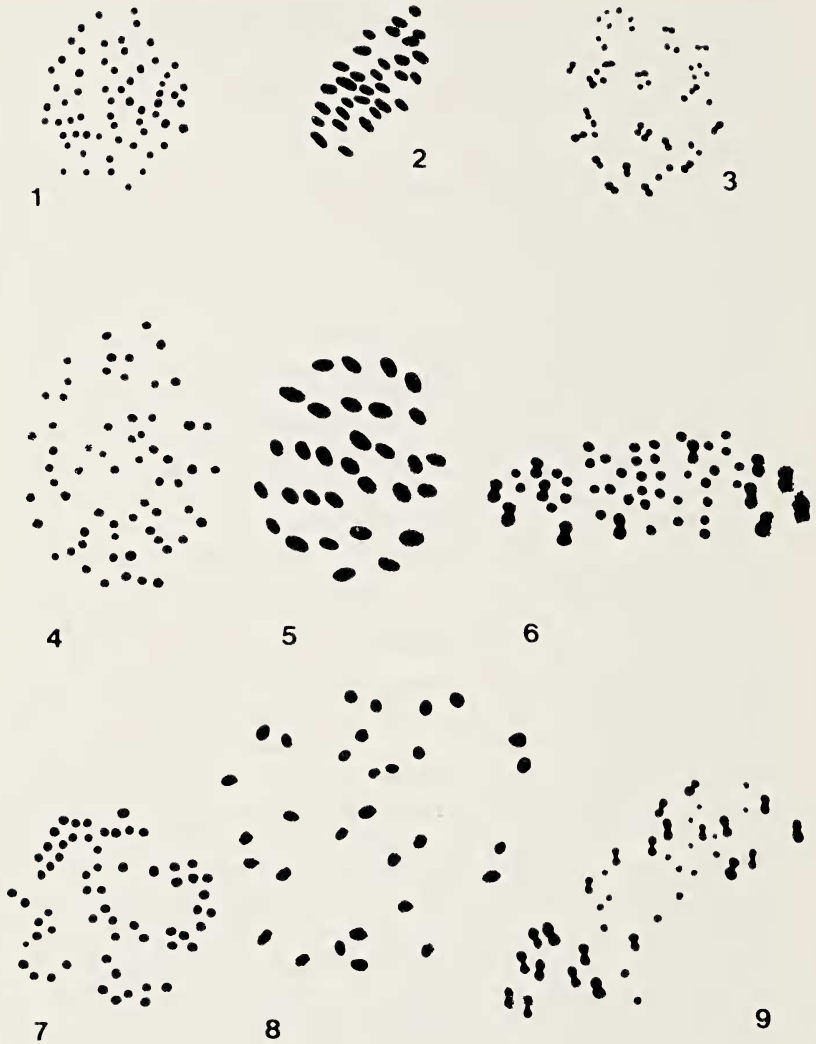


Fig. 1 to 3 Meiotic chromosomes of *A. ricini*. x2000 (Approx.). Fig. 1 gonial metaphase Fig. 2 metaphase I Fig. 3 abnormal diakinesis showing 18 bivalents and 26 univalents. Fig. 4 to 6 Meiotic chromosomes of *P. gloriosae*. Fig. 4 gonial metaphase Fig. 5 metaphase I Fig. 6 abnormal metaphase I showing 12 bivalents and 38 univalents. Fig. 7 to 9 Meiotic chromosomes of *P. lemonias*. Fig. 7 gonial metaphase Fig. 8 metaphase I. Fig. 9 abnormal metaphase I showing 22 bivalents and 18 univalents.

almost in close correspondence with that of Srivastava and Gupta (1962) and Virrki (1963). In all the three species viz. *Z. ricini*, *P. gloriosae* and *P. lemonias* normal diakinesis and first metaphase nuclei showed 31 bivalents. The diakinetik bivalents showed chiasma configurations. Exceptionally, a low frequency of cells showed many univalent chromosomes along with few bivalents at metaphase I. The univalent chromosomes lie in closely associated but quite separated pairs and are the homologues of corresponding bivalents of normal cells. The univalents result either from precocious terminalisation of chiasmata or have been formed without homolog pairing in meiotic prophase. The latter appears more probable. If there had been precocious terminalisation of chiasmata, so many chromosomes would not have been involved early in diakinesis, when in corresponding normal cells all the chromosomes have chiasmata continued up to metaphase I. Again in that case the univalents would indicate splits into chromatids, which they did not do. Such independence of the chromatids would lead to post reductional meiosis as in females while prereducational meiosis occurs in the males. In the vast majority of cases the chromosomes enter metaphase as single bodies. Since unpaired chromosomes appear at early diakinesis their resolution might have occurred still earlier in a diplotenic split between homologues. The frequency of such cells showing asynaptic meiosis, though infrequency, is not insignificant. Furthermore, their number increases from early pupa to late pupa where all the chromosomes of such cells show the feature. This corresponds with similar observations made by Virrki (1963) in *D. saccharalis*. Anomalous pairing was also reported by Federley (1943) in *Dieranura* hybrids where the homologous chromosomes did not pair. However, there is no indication of hybridism here, since the phenomenon does not involve all cells. Although asynaptic segregation of homologues usually leads to anaphasic irregularities producing abnormal spermatozoa that perish, normal segregation also occurs, since at metaphase II invariably 31 chromosomes have been scored in all cells.

The exact cause of such a synaptic formations are speculative. Beadle (1933) holds a single gene to be responsible for such anomaly in dysynaptic maize. Virrki (1963) has considered chromosome events to have influence on asynapsis in *Diatrea* where the asynaptic chromosomes appeared undercondensed in premetaphase and metaphase of first division. In his opinion genes and environment are not the only factors controlling asynapsis which appears only at a certain developmental phase. He presumes some other development control factors

to be involved. Studies on the development of insects have revealed that larval ontogenesis and continuation of gametogenesis are under the control of the juvenile hormone (HR) secreted by the corpora allata. Before pupation this hormone ceases. The ineffectiveness of this hormone causes abortive trends in meiosis during pupal stages while the prothoracic hormone, ecdysone, maintains normal spermatogenesis. Consequently it may be concluded that both genic and hormonal factors are responsible for the appearance of asynaptic meiosis in Lepidoptera.

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Literature Cited

- BAUER, H. 1953. Die chromosomenreduktion (Meiose). In: Allgemeine Biologie (ed. by M. Hartmann), 4 Aufl. Stuttgart: Gustav Fischer.
- BEADLE, G. W. 1933. Further studies on asynaptic maize. *Cytologia* 4, 380-387.
- BEERMANN, W. 1954. Weibliche Heterogametic bei Copepoden. *Chromosoma* 6, 381-396.
- FEDERLEY, H. 1943. Zytologische untersuchungen and Mischlingen der Gattung *Dicranura* (Lepidoptera). *Hereditas* 29, 205-254.
- FEDERLEY, H. 1945, b. Die Konjugation der chromosomen bei den Lepidopteran. *Comment. at Biol.* 9, 1-12.
- KUHN, A. and BERG, B. Z. 1955. Zur genetischen Analyse der Mutation Biochemica Von *Ephestia kuhniella*. *Z. induct. Abstamm. U. Vererblehre.* 87, 25-35.
- MAEDA, T. 1939. Chiasma studies in the silkworm *Bombyx mori* L. *Japan. J. Genet.* 15, 118-127.
- SRIVASTAVA, M. D. L. and GUPTA, Y. 1962. Meiosis in the spermatocytes of *Philosamia ricini*, Family: saturnidae, Lepidoptera. *Naturwiss.* 49, 612-613.
- SUOMALAINEN, E. 1965. On the chromosomes of the Geometrid moth genus *Cidaria*. *Chromosoma* 16, 166-184.
- SUOMALAINEN, E. 1969 b. On the sex chromosome trivalent in some Lepidoptera females. *Chromosoma* 28, 298-308.
- SUOMALAINEN, E., COOK, L. M., and TURNER, J.R. G. 1973. Achismatic oogenesis in the Heliconin butterfly. *Hereditas* 74, 302-304.
- TRAUT, W. 1977. A study of recombination, formation of chiasmata and synaptonemal complexes in female and male meiosis of *Ephestia kuhniella* (Lepidoptera).
- ULLERICH, F. H. 1961. Achismatische spermatogenese bei der skorplonsfliege panorpa (Mecoptera). *Chromosoma* 12, 215-232.
- WHITE, M. J. D. 1973. *Animal cytology and Evolution*, Cambridge University press, London.